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REPORT

OF

WESTERN PINE BEETLE STUDIES AND EXPERIMENTS

ON THE CASCADE UNIT, NORTHFORK, CALIF.,

SEASON OF 1925.

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P.O. Box 3010,
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I. CONTROLLED ATTACKS ON TREES OF VARYING GROWTH RATE.

The object of this experiment was to determine if trees of vigorous growth rate offered greater resistance to barkbeetle attack than less vigorous trees.

Detail of Experiment.

The method consisted of enclosing the lower 10 feet of the trunk in a beetle tight cage. A certain number of beetles were confined within the cage by placing a quantity of infested bark in the cage and allowing the new adults to emerge. The attack of these adults was therefore forced into the base of the tree. If successful in establishing their attack the attraction brought in beetles flying in the area to the bark surface outside of the cage so that the entire tree was infested.

Two cages were constructed, using a screen of 18 mesh to the inch. The type of cage construction is shown in photo No. 1. Two trees were selected for the experiment which represented as far as possible the opposite extremes of vigor as expressed by growth characters. The following is a comparison of the two trees selected for the experiment and summarized notes on the attack:

	Cage No. 1 Tree No. 25a	Cage No. 2 Tree No. 1815
D.B.H.	36"	28"
Ht.	120'	110'
Crown Class	dominant	intermediate
Crown form	pointed	flat
" length	long	short
" width	wide	narrow
No rings in last in.	5	62
Ring width 1925	3.72 mm	.01mm
1924	3.30 mm	.25mm
1923	7.20 mm	.25mm
1922	4.72 mm	.35mm
Total sq. ft.of infested bark placed in Cage Aug. 14,1925.	76.4	65.5
Total sq. ft. of infested bark placed in cage Sept. 8,1925	58.9	-
Total new adults emerging Aug. 27 to Sept. 20	14559	8373
New attacks on bark surface within cage, Aug. 27, to Sept. 20	430	645
New attacks outside for 2½ feet above top of cage	20	175

Cage No. 1 - Cont'd.	Cage No.2 -Cont'd.
Balance of tree not attacked	Balance of tree infested to top.

The following are summarized observations made during the progress of the attack:

Predators.

Adults of *Thanasimus nigriventris* appeared about cage 2 on August 21 some days before emergence of beetles started. These clerids were abundant both inside and outside of the cages during the entire period of emergence. They worked actively upon the D. b. adults on the bark surface and undoubtedly killed great numbers of them. These clerids no doubt accounted for some of the reduction of beetles in the cages represented by the great surplus of emergence over attack in the cages.

It is something of a mystery as to what became of all the beetles that emerged in the cages. Of the 14599 which emerged in Cage 1 not over 1,000 could be accounted for by the 430 attacks in the cage. A great deal of this loss was apparently due to beetles getting out of the cage as it was found that there was a chance for leakage around the base of the cages.

Attacking Habits of D. brevicomis.

The activity of the beetles both within and outside of the cages started usually from 7 to 8 a.m. depending upon the temperature. This activity continued until dusk. By placing the ear against bark, noise made by the adult beetles in cutting their galleries could be heard. This noise was noted at 8:00 p.m. and at 6 a.m. indicating that the activity within the tree does not die down at night.

Relative Attraction of Trees and Resistance to Attack.

Tree 25a, Cage 1.

Both trees made very conspicuous pitch tubes but those on the tree in Cage 1 were considerably larger than those in cage 2. In Cage 1 the attacks were concentrated on the southwestern exposure of the trunk which received considerable sun in the afternoon. The beetles usually gathered on the walls on this side the cage and they seemed to show something of an aversion to attack as they crawled about over the walls of the cage in numbers rather than alighting on the tree. Although numbers of adults were in the cage on August 27 the first attacks did not appear until August 30. Only 20 attacks occurred on the entire tree above the cage indicating that the attraction set up by the attack within the cage was very much less than for Cage 2. This result indicates that in resistant trees, other factors influence the attraction aside from that set up by the attacks which have already been started on the tree.

Tree No. I 815, Cage 2.

In cage 2 the attack occurred on all sides of the tree in the cage and was noted on the first day that emergence was observed. Attack above the cage was also noticed on this same date. Within a week after emergence started the entire tree was thoroughly attacked showing pitch tubes all the way to the top of the thick bark.

On August 27 it was noticed that 2 large yellow pine trees within 15 feet of the cage were also being attacked, the beetles just entering. Within a week the attack was extended to other trees until the group included a total of 7 yellow pine ranging from 20 to 50 inches D.B.H. The attack and subsequent brood development on all trees progressed simultaneously with that in the cage tree.

It is evident, therefore, that the slow growing tree selected for cage 2 not only failed to resist the attack but also that some very strong attraction was set up which brought beetles to surrounding trees in great numbers. This attraction may have been started first by the attack of beetles confined within the cage. Or it may be that by chance a tree was selected which was already attractive to beetles and that the group would have been killed if no artificial attack at all had been induced. The latterseems quite probable in view of the heavy attacks which occurred on the area during the fall of 1925.

II. ARTIFICIAL ATTRACTION OF D. BREVICOMIS TO LIVING TREES.

Attempts in 1922 to attract beetles to girdled yellow pine failed to induce attack during that season. So far it has been found that only by felling the entire tree can an attack be assured.

It has often been stated that lightening scars under a tree attractive to these beetles and it was decided to try to produce a scar similar to that left by a moderate stroke of lightening. The following is the detail of this experiment.

Detail of Experiment.

Four trees were selected ranging from 15 to 37 inches D.B.H. Two of these trees of slow growth are represented by increment borings while two represented fairly vigorous. The trees were climbed and a scar about 2½ inches wide made a point near the top to the base. This scar was made with a small size by cutting through the cambium and exposing the sapwood which was hacked to a depth of a fraction of an inch. A blow torch was then used to heat the scar on one fast growing and one slow growing tree until the wood was slightly charred. The trees were then examined at intervals during the summer for evidence of attack.

Tree No.	1	2	3	4
D.B.H.	20"	15"	26"	37"
Height	120'	50'	130'	120'
Rate of growth	slow	slow	vigorous	vigorous
Date of scar	Feb. 8	July 8	July 8	July 8
Width of scar strip.	3"	3"	3"	3"
Length of scar	60'	40'	95'	75'
Treatment of scar.	heated	-	heated	-

Results noted, September 25, 1925.

Tree No. 1

No attack by D. brevicomis. Two attacks of D. valens at base of scar. Within less than 100' of this tree a group of 3 yellow pines 20" to 28" D.B.H. were attacked by D. brevicomis Aug. 15 to 25.

Tree No. 2

No attack by any insects. The group of 3 yellow pine attacked August 15 to 25 was within 75' of this tree.

Tree No. 3

No attack by any insect.

Tree No. 4

No attack by any insects. Heavy flow of pitch from scar.

It is perfectly evident that these artificial scars did not attract D. brevicomis to the trees. The fact that the beetles did attack and kill 3 trees within 100 feet of the experiment indicates that failure of attack was not due to lack of beetles flying in the vicinity.

Two lightening struck were also under observation during the summer. One of these located at Lion Point was struck July 4 at about the same time that the artificial scars were made. Up to Sept. 25 this tree had been attacked only by D. valens at the base.

The other lightening struck tree was hit Feb. 25th, 1925, and was not attacked by any insects during the season.

Attraction to Freshly Cut Logs.

Although not planned as a part of this experiment the rustic pole experiment described next indicates that a very decided attraction may be set up by this sort of material. Not only was D. brevicomis attracted to the logs but the beetles also attacked a group of 14 trees of pole size alongside of the poles that were being sun cured. This attack occurred in July soon after the poles were cut and seems to have been localized by the attraction of this material.

III. SUN CURING OF RUSTIC POLES TO PREVENT LOOSENING OF BARK BY BARKBEETLES AND BORERS.

As this method has been suggested for seasoning yellow pine poles so that they can be used in rustic work without subsequent loosening of the bark, the following experiments were tried out:

Experiment A.

June 17, 1926 - A series of 15 poles, 10' in length and 6" to 10" at the base, were cut trimmed and placed on the ground on an exposed flat. These logs were given a turn ¼ around every 5 days until August 5. The logs were then moved into a shaded position. A final examination of their condition was made September 25, 1925.

During the period while the logs were being turned they were repeatedly attacked by D. brevicomis on the shaded underside of the log. When these new attacks were turned up to the sun the parent adult beetles were killed out during the 5 days exposure. Attacks by flat headed borers (melanophila sp.) also developed slowly in the logs but these did not appear to be affected by the solar heat treatment.

No Ips attacks occurred in these logs. This is probably due to the fact that the logs were cut after the spring flight of these beetles was over.

On Sept. 25, all logs were thoroughly examined to determine whether or not insect attacks had been presented and the poles were seasoned suitably for rustic work.

On one log only the bark had been seasoned so that it adhered to the log and was too dry for barkbeetle attacks. On all the other logs the greater part of the bark surface had been loosened by flatheaded borers, and patches of bark not mined by these larvae were still green.

The log which was successfully seasoned was only five inches in diameter so it seems to have dried out readily because of its thin bark surface.

As a check against this experiment 6 poles of similiar size were cut on the same date as the poles for seasoning. These were placed in the shade and covered with brush so as to offer favorable conditions for attacks by barkbeetles. The entire barksurface of the check logs was infested by D. brevicomis within two weeks after they were cut. The broods from these attacks completed their development but emergence was somewhat below normal.

Experiment B.

June 26, 1925 - A series of 20 poles ranging from 5 to 12 inches at the base were cut and placed on the ground on an exposed flat. These logs were given ½ turn every 10 days. They were given therefore one complete turn during the 20 days that they were left exposed to the sun. The logs were then placed in the shade. On Sept. 25 these logs were examined to determine results.

It was found that in all logs results were similar to those in Experiment B. The attacks of D. brevicomis had been killed out by solar heat but the flat heads had so thoroughly infested the bark surface that it was unsuited for rustic uses to the same extent as if it had been loosened by barkbeetle work.

Weather conditions throughout the period of June and July while these tests were in effect, included several periods of high temperatures and low humidity. There were no rains and conditions were as favorable as could be expected for rapid seasoning of this material.

These tests indicate that the sun curing of poles will prevent loosening of the bark by barkbeetles but that it will not prevent loosening by flatheaded borer work.

IV. GROUP SELECTION BY THE WESTERN PINE BEETLE.

Detail of Study.

Early in July a group of 10 yellow pine were attacked by D. brevicomis about ½ mile northwest of the Cascadel ranch buildings. This group was located on the most favorable site conditions of the area. The majority of the trees in this group were dominants and they appeared to be fully as vigorous as other trees not attacked on the same site. The question as to why the beetles selected the trees in the group and not the adjoining ones came up for consideration and a sample plot was laid out to study the group from this angle.

A 2 acre plot was selected so as to include only the Site I condition on which the group stood. This plot was 2 chs. wide by 10 chs. long extending N.W. to S.E. The group was approximately in the center of this strip.

Each tree on the plot over 12 inches D.B.H. was numbered, measured by Biltmore scale, estimated for height and an increment core taken. Data was also taken on crown class, form, length, and width. The ring growth of the cores was measured in millimeters for the past 6 years and the number of rings in the last inch counted. Records were taken from 34 trees on the plot.

Selection of Trees According to Growth Rate as Expressed by Ring Width.

As the site conditions was similar for all trees this could not have entered into the preference shown by the beetles on this plot.

Vigor of growth as expressed by ring width varied to a considerable extent in all trees and may have had something to do with preference in attack. As the ring width expresses difference in growth rate only in the same diameter classes the trees have been grouped according to green trees and D.b. killed trees in 4 inch diameter classes. This grouping is shown in Table I.* As there were no insect killed trees in the classes under 12 inches the 10 green trees below this diameter were not included in the table.

In the 21 to 24 inch class the beetles selected the two slower growing trees. They did not attack tree No. 22 which had the same number of rings to the inch as tree 665, but the tree selected made an appreciably slower growth in 1924.

In the 25 to 28 inch class the beetles killed one and left the other of the two slowest growing trees. These two trees were indentical in all respects except that the tree attacked shows a much more appreciable checking of the growth in 1924 as compared with 1923. In the 29" to 32" class, the beetles selected the slowest growing trees on the plot. However, they also selected tree 660 which was growing approximately as fast as tree No. 18. In this case the tree attacked shows much less checking of the growth in 1924 than does the tree that was left.

In the 37 to 40 inch class the beetles selected take two fastest growing trees and left the slowest growing tree. In attacking tree 666 they selected what, from all indications, was the fastest growing tree on the plot. Although this tree was not growing as fast as the tree which was enclosed in Cage 1 it had all the external evidences of vigor. It is difficult to understand just why the insects selected this tree and at the same time could not be induced to attack the tree in Cage 1.

*For Table I see the following page.

TABLE I.

GROWTH RATE OF GREEN AND INSECT KILLED TREES BY DIAMETER CLASSES

Diameter Class	Tree No.	DBH	Ht.	Rings last inch.	Width of Annual Ring 1920	1921	1922	1923	1924
21" to 24"									
Green trees									
	20	24"	85'	19	1.57	1.73	1.60	2.77	1.07
	22	22"	100	17	1.54	1.90	1.27	1.90	1.10
Db. killed trees									
	662	24"	120'	30	.85	.81	.94	1.39	.54
	665	24"	70'	17	1.32	1.79	1.23	1.89	.92
25" to 28"									
Green trees									
	27	28"	100'	22	1.50	1.50	1.08	1.30	.67
	10	28"	110'	19	1.43	1.41	1.22	2.43	.91
	14	28"	70	11	2.07	2.71	2.87	3.30	1.90
	24	28	150	8	3.45	3.98	2.98	4.07	2.70
Db. killed trees									
	663	28	130	20	1.24	1.55	1.20	1.80	.64
29" to 32"									
Green trees									
	6	32"	125'	19	1.20	1.70	.87	1.92	.72
	18	32	60	12	2.57	2.38	1.25	3.82	1.30
	23	30	140	18	1.40	1.45	1.51	2.30	1.00
Db. killed trees									
	657	32	100	53	.10	.10	.10	.10	.09
	658	32	110	39	.42	.27	.33	.24	.35
	659	30	125	15	2.10	2.18	1.70	2.87	1.22
	660	30	125	11	2.29	2.40	2.20	2.84	1.74
	664	32	100	17	1.33	1.08	1.32	2.09	.94
33" to 36"									
Green trees									
	26	34"	140'	10	2.52	3.24	2.85	3.80	1.54
	21	36	130	36	.84	.89	.90	1.47	.41
No Db killed-trees.									
37" to 40"									
Green trees									
	25	40"	140'	18	.95	1.52	1.48	1.60	.52
Db killed trees									
	661	38	145	12	1.85	2.03	2.35	3.01	1.03
	666	38	140	10	3.04	3.88	2.70	3.50	1.82
Over 40"									
Green trees									
	1	50	140	32	.82	.68	.74	.86	.75
	2	50	140	53	.45	.45	.30	.45	.25
No Db killed trees.									

Attacks per square Foot of Bark.

In the fall of 1925, 9 trees of the group were cut and bark counts made of the number of entrance and exit holes from 2 square feet of bark at 10 foot intervals along the trunk.

These counts have not been thoroughly analyzed but it is evident that the attack on all trees in the group was fairly uniform and normal. The entrance holes average from 8 to 15 per square foot and apparently do not vary according to the rate of growth or other indications of vigor in the tree.

Selection According to Crown Characters.

Table II gives a summary of the crown characters of the 24 trees included in Table I. It is difficult to work out any indication of preference from this table.

TABLE II.

Comparison of Crown Characters of Green and Insect Killed Trees.

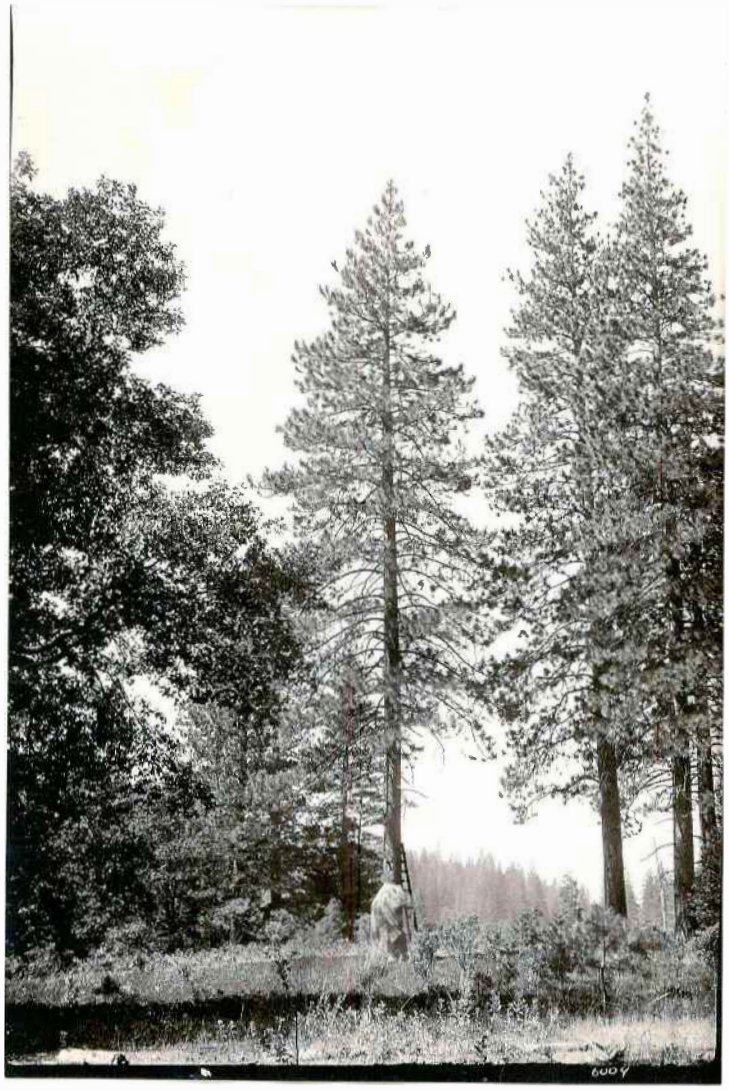
	Number		
	Green trees.	D.b. Killed.	Total
Crown Class			
Dominant	9	9	
Codominant	2		
Intermediate	1		
Suppressed	2	1	24
Crown Form			
Pointed	4	5	
Round	7	4	
Flat	3	1	24
Crown Length			
Long	5	3	
Medium	3	6	
Short	6	1	24
Crown Width			
Wide	7	2	
Medium	5	5	
Narrow	2	3	24

The only conclusion that can be drawn from this limited study is that little if any preference was shown by the beetles in selecting the trees of this group. The concentration of beetles at this point was caused by some other factor than a weakened condition of the trees. The priority of attack may have been on the slower growing trees in the group but this point could not be determined. In general the evidence bears out Person's position that once the beetles have built up in numbers, as they did in 1924, the subsequent attacks are likely to be quite indiscriminate so far as tree selection is concerned.

Photo No. 1

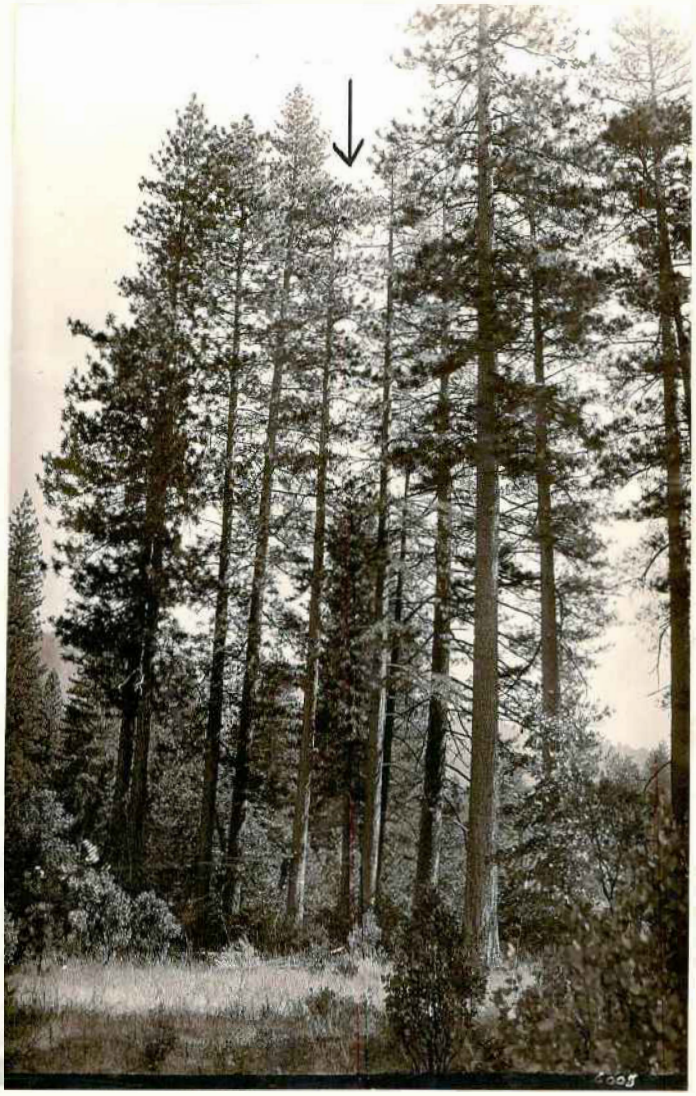
Cage No. 1 built around the base of fast growing yellow pine.

Photo No. 2



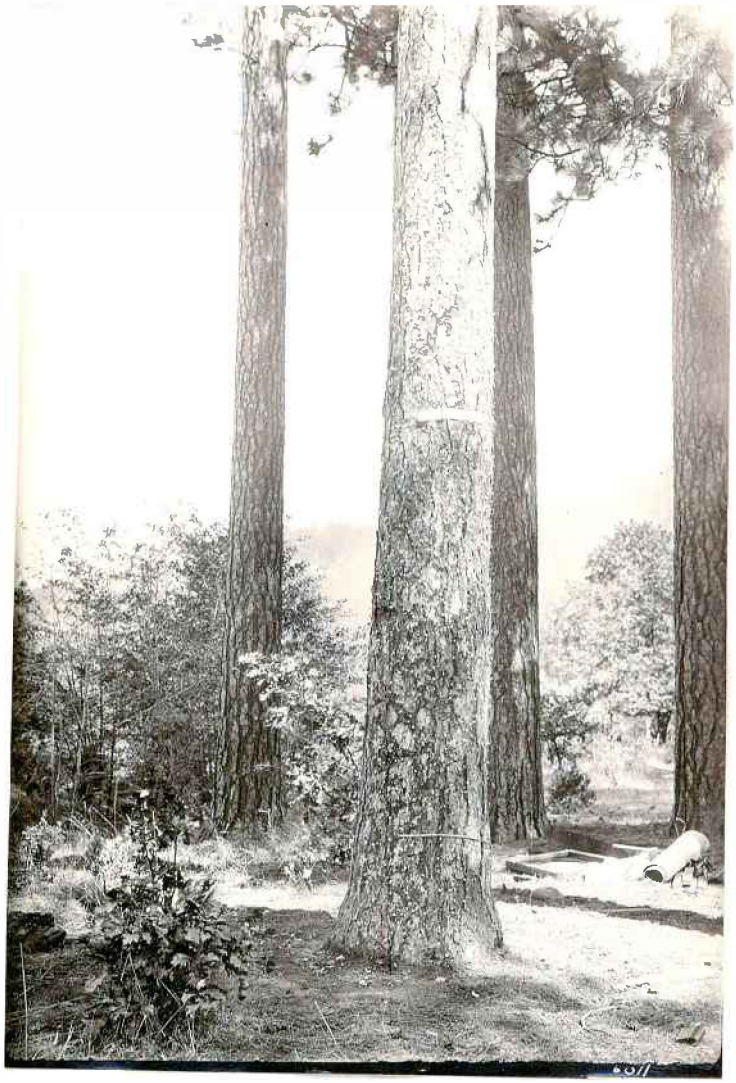
Showing fast growing tree selected for Cage No. 1. This tree was standing on Site 1. Vigor is also indicated by the long pointed crown. The beetles failed to overcome the resistance of this tree.

Photo No. 5



Arrow indicates tree at the base of which cage No. 2 was installed. This tree was on Site I but was in the intermediate crown class. Note flattened crown. The growth rings of this tree were microscopic in character.

Photo No. 4



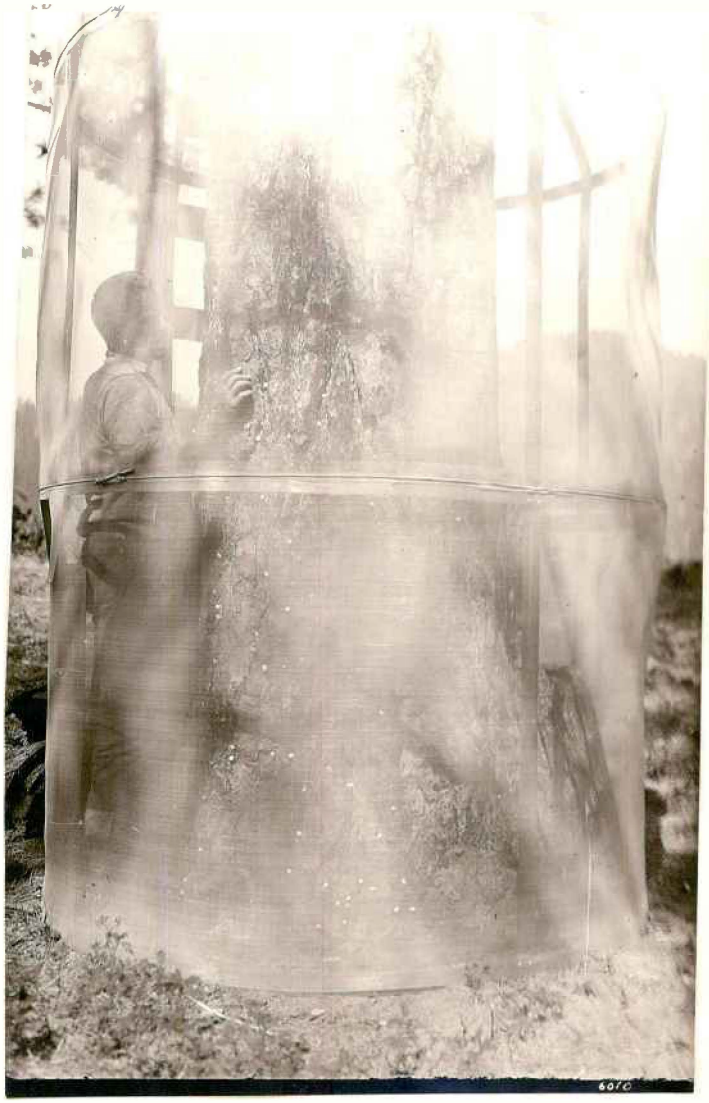
After the attack of the beetles was thoroughly established Cage No. 2 was removed. Top of cage is indicated by the white mark on trunk. A pin with white paper square attached to its head was stuck into the bark at each entrance hole of the beetles. The attacks were marked in this manner for 2½ feet above the top of the cage.

Photo No. 5

Base of tree after cage 2 was removed showing entrance hole of D. brevicomis marked with pins stuck through white paper squares. Pitch tubes can be seen at some of the points where pin is stuck into the bark.

Negative No.6012

Photo No. 6



Morrow at work in Cage 1 marking the entrance holes of D. breviconis with pins stuck through white paper squares. New attacks were marked in this fashion each day so that the daily number in attacks could be kept separately.